# NORTH FORK OF CLEAR CREEK PROJECT
# RESTORATION OF ABANDONED MINE SITES

# DRAFT REPORT

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## TABLE OF CONTENTS



## TABLES



## FIGURES

## APPENDICES



## ATTACHMENTS

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ASTM | American Standard Testing Materials |
| $^{o}C$ | Degrees Celsius |
| CDMG | Colorado Division of Minerals and Geology |
| CDQAR | Chemical Data Quality Assessment Report |
| CENWO | Corps of Engineers, Omaha District |
| COC | Chain-of-Custody |
| DQOs | Data Quality Objectives |
| DUP | Duplicate |
| ECB | Environmental Chemistry Branch |
| EPA | Environmental Protection Agency |
| FSP | Field Sampling Plan |
| Ft | Foot/Feet |
| GPS | Global Positioning System |
| IDW | Investigative Derived Waste |
| Kg | Kilogram |
| L | Liter |
| LIMS | Laboratory Information Management System |
| MDL | Method Detection Limit |
| MRL | Method Reporting Limit |
| µg/L | Micrograms per Liter |
| mg/kg | Milligrams per kilogram |
| mg/L | Milligrams per Liter |
| mg | Milligram |
| Min | Minute |
| mL | Milliliters |
| MS/MSD | Matrix Spike/Matrix Spike Duplicate |
| N/A | Not Applicable |
| ND | non-detect |
| ppb | Parts per Billion (measured in water as µg/L) |
| QA | Quality Assurance |
| QC | Quality Control |
| RAMS | Restoration of Abandoned Mine Sites |
| RPD | Relative Percent Difference |
| SSHP | Site Safety Health Plan |
| SOP | Standard Operating Procedure |
| SSA | Site-Specific Addendum |
| U.S. | United States |
| USACE | U.S. Army Corps of Engineers |
| USBR | U.S. Bureau of Reclamation |
| USFS | U.S. Forest Service |
| WRDA | Water Resource Development Act |

# 1 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) has been provided authority for Restoration of Abandoned Mine Sites (RAMS) through the Water Resource Development Act (WRDA) 1999 Section 560. The RAMS program is a regionally focused and stakeholder responsive program for the restoration of abandoned and inactive non-coal mines where water resources (ecosystem/habitat) have been degraded by past mining practices. This authority is intended to allow the USACE to provide support to agencies that manage lands impacted by past mining. The USACE coordinated in advance to obtain stakeholder buy-in on all work proposed to be performed by Corps Districts to ensure that the proposed work is supportive of the stakeholders' efforts in the area.

The USACE Omaha District is working in coordination with the Colorado Division of Minerals and Geology (CDMG) and the Bureau of Reclamation (USBR) on the North Fork of Clear Creek RAMS Project. The CDMG and USBR identified the data needs for this drainage. The USACE obtained the necessary right-of-entry (ROE) to the identified locations. Individuals from the USACE Omaha District and USACE Albuquerque District performed the fieldwork from September 9 through September13, 2002.

The purpose of this report is to submit documentation of the field activities and analytical results to the CDMG, the primary data user. This report includes the methods and procedures used for collecting surface soil and sediment samples, data quality review, the field forms, and site photos. This report does not include any interpretations or conclusions based on this data.

# 2 PROJECT INFORMATION

## 2.1 Site Description

The North Fork of Clear Creek drainage basin encompasses approximately 90% of Gilpin County in north-central Colorado near Central City, Colorado. Gilpin County is one of the most intensely mined counties in Colorado, particularly from Central City south to the county line. Three major tributaries to the North Fork of Clear Creek drain this heavily mined area, which are Chase Gulch, Nevada/Gregory Gulch, and Russell Gulch. Within these three drainages, there are an estimated 2,000 mine waste piles.

The North Fork of Clear Creek is within the Clear Creek Superfund study area. Superfund characterization activities within this basin have focused on mine drainages. Very few of the mine waste rock and mill tailing piles have been characterized in Gilpin County. The numerous waste rock and mill tailing piles contain acid forming materials (e.g. pyrite, chalcopyrite, etc.) and contain high levels of leachable zinc, copper, manganese, lead, and iron.

## 2.2 Project Objectives

The primary objective of this field investigation is to collect and provide surface soil and sediment data to the CDMG and USBR to support their respective investigations for the North Fork of Clear Creek drainage. This data may eventually be used by the CDMG and/or the USBR in order to determine metals loading from various mine waste pile sites to the North Fork of Clear Creek drainage.

The goal of this initial phase is to identify potential contaminant sources throughout a watershed. A site visit was conducted on 23 July 2002 to perform a cursory survey of project area to identify and prioritize waste piles. Due to the vast number of waste piles, but with limited investigative funds and right-of-entry (ROE) access agreements with the landowners, only 27 of the 43 highest priority waste piles identified in the Site Specific Addendum (SSA) of the Work Plan were sampled. In addition, four sediment sample locations from Chase Gulch were collected for data to ascertain if run-off from the waste piles has impacted the Chase Gulch drainage.

# 3 FIELD INVESTIGATION

## 3.1 Field Investigation Activities

A single round of sediment and surface soil samples were collected in accordance with the approved Work Plans. Sampling locations are shown on Figure 3-1 and listed in Table 3-1. Sampling location coordinates were obtained from a hand-held Global Positioning System (GPS) device. These measurements were recorded on the field data sheets in longitude and latitude. The device has an approximate accuracy of plus-or-minus 25 to 75 feet.

The following Standard Operating Procedures (SOPs) identified in the Site-Specific Addendum (SSA) to the RAMS Work Plan were adhered to during the course of this field investigation: A1 (Surface Soil/Rock Sampling Equipment and Procedures); A4 Soil/Rock Homogenization Equipment and Procedures, A7 (Investigative Derived Waste Procedures); A12 (Equipment Decontamination Procedures); A13 (Sample Handling, Documentation, and Tracking Procedures); and A14 (Field Documentation).

## 3.2 Surface Soil Samples

A total of twenty-seven (27) field samples and four duplicate samples of surface soil were collected from seventeen sampling locations from Chase Gulch (CHG-2 through CHG-11, CHG-13 through CHG-16, CHG-18, CHG-20, and CHG-21) and ten sampling locations from the lower Gregory Gulch (LGG-22, LGG-25 through LGG-27, LGG-31 through LGG-34, LGG-36, and LGG-37). Duplicate samples were collected from sampling locations CHG-8, CHG-11, LGG-26, and LGG-37. A visual reconnaissance was performed on each of the sampled waste piles. The latitude/longitude, approximate distance from a defined drainage channel, degree of erosion, volumetric measurements, presence and approximate size of vegetation kill zone, presence of vegetation on the waste piles, texture of waste pile, degree of cementation of the waste pile, and equipment access description were documented. This information is documented on the data sheets in Appendix B. The coordinates and sample identification numbers are listed in Table 3-1.

All surface soil samples were submitted to the USACE Environmental Chemistry Branch (ECB) Laboratory for total metals of the soil and leachable metals, pH, acidity, and conductivity from the water leachate of the soil.

## 3.3 Sediment Samples

A total of four field samples and one duplicate sample were collected of the creek sediment in Chase Gulch. A composite sample was collected from the banks or the sediment immediately adjacent to the creek. All sediment samples were submitted to the USACE Environmental Chemistry Branch (ECB) Laboratory for total metals of the sediment and leachable metals, pH, acidity, and conductivity from the water leachate of the sediment.

### 3.4 Sample Identification Scheme

The sample ID scheme presented in SOP A13 was modified to the following designation.

**UU-VVV/VVV02-XXXX-ZZ**

where:

**UU** = Project designation was replaced with **CO** (for Colorado RAMS)
**VVV/VVV** = Designation of sampling area location was replaced with

- **NCC/LGG** for North Fork of Clear Creek- Lower Gregory Gulch
- **NCC/CHG** for North Fork of Clear Creek -Chase Gulch

**02** = Year of sampling
**XXXX** = **SS** (surface soil) or **SD** (sediment sample) plus the two-digit sample location number
**ZZ** = 2 Character Designation for Samples, where:

01 = Normal Field Sample
02 = QC Duplicate

**Examples:**
A surface soil sample from location #11 collected from Chase Gulch of the North Fork of Clear Creek site is:

CO-NCC/CHG02-SS11-01

The QC duplicate sample has the sample designation of:

CO-NCC/NGG02-SS11-02

**Table 3-1**

| ID NO. | WASTE PILE NAME | DRAINAGE | LATITUDE | LONGITUDE |
|---|---|---|---|---|
| CHG-2 | Two Sisters | Chase Gulch | N39º 48’ 32.7” | W105º 31’ 29.1” |
| CHG-3 | Ellery | Chase Gulch | N39º 48’ 22.2” | W105º 30’ 43.0” |
| CHG-4 | Belden Tunnel | Chase Gulch | N39º 48’ 27.3” | W105º 30’ 43.4” |
| CHG-5 | Allie | Chase Gulch | N39º 48’ 23.8” | W105º 30’ 43.7” |
| CHG-6 | Sans Souci | Chase Gulch | N39º 48’ 28.9” | W105º 30’ 37.1” |
| CHG-7 | Castle Rock | Chase Gulch | N39º 48’ 27.8” | W105º 30’ 46.8” |
| CHG-8 | Lower Centennial | Chase Gulch | N39º 48’ 24.3” | W105º 30’ 28.4” |
| CHG-9 | Advance Tunnel | Chase Gulch | N39º 48’ 33.1” | W105º 30’ 50.5” |
| CHG-10 | Hayseed Tunnel | Chase Gulch | N39º 48’ 40.7” | W105º 30’ 56.3” |
| CHG-11 | Tucker | Chase Gulch | N39º 48’ 42.6” | W105º 30’ 56.7” |
| CHG-13 | Centre Tunnel | Chase Gulch | N39º 48’ 26.5” | W105º 30’ 30.2” |
| CHG-14 | Upper Centennial | Chase Gulch | N39º 48’ 22.9” | W105º 30’ 33.3” |
| CHG-15 | Robert Emmet | Chase Gulch | N39º 48’ 27.7” | W105º 30’ 21.1” |
| CHG-16 | Virginia Discovery | Chase Gulch | N39º 48’ 33.1” | W105º 30’ 29.3” |
| CHG-18 | Bates | Chase Gulch | N39º 48’ 7.2” | W105º 30’ 59.3” |
| CHG-20 | Bonanza Tunnel | Chase Gulch | N39º 48’ 20.0” | W105º 30’ 14.7” |
| CHG-21 | Aetna | Chase Gulch | N39º 48’ 18.6” | W105º 30’ 16.0” |
| LGG-22 | Boston | Gregory Gulch | N39º 47’ 58.1” | W105º 30’ 39.5” |
| LGG-25 | Humboldt | Gregory Gulch | N39º 48’ 12.7” | W105º 30’ 6.4” |
| LGG-26 | Winnebago | Gregory Gulch | N39º 48’ 14.1” | W105º 30’ 50.8” |
| LGG-27 | Hunter-Gold Extension | Gregory Gulch | N39º 47’ 48.7” | W105º 30’ 38.5” |
| LGG-31 | Next President | Gregory Gulch | N39º 47’ 56.8” | W105º 30’ 12.2” |
| LGG-32 | Hartford | Gregory Gulch | N39º 47’ 57.0” | W105º 30’ 16.4” |
| LGG-33 | Maine-Hamlet | Gregory Gulch | N39º 47’ 54.9” | W105º 30’ 34.4” |
| LGG-34 | Vasa-Levant | Gregory Gulch | N39º 47’ 59.7” | W105º 30’ 23.6” |
| LGG-36 | O.K. (Epizootic) | Gregory Gulch | N39º 47’ 54.1” | W105º 30’ 36.3” |
| LGG-37 | German | Gregory Gulch | N39º 47’ 52.8” | W105º 30’ 32.7” |
| | SEDIMENT SAMPLES | | | |
| SD-1 | | Chase Gulch | N39º 48’ 43.6” | W105º 30’ 58.7” |
| SD-2 | | Chase Gulch | N39º 48’ 36.7” | W105º 30’ 54.1” |
| SD-3 | | Chase Gulch | N39º 48’ 25.0” | W105º 30’ 27.0” |
| SD-4 | | Chase Gulch | N39º 48’ 18.8” | W105º 30’ 15.0” |

# 4 LABORATORY ANALYTICAL RESULTS

## 4.1 Data Quality Objectives

The Data Quality Objectives for this project are those presented in the RAMS Final Work Plan dated July 2002. The criteria in order to attain these objectives are given in the RAMS Final Work Plan and/or presented in this section. The Method Detection Limit (MDL), Method Reporting Limit (MRL), and QC criteria that will meet the data objectives for metals are given in Tables 6-5 and 6-6 of the RAMS Final Work Plan. The MDL, MRL, and QC criteria that will meet the data objectives for conductivity, pH, and acidity are given in Table 6-7 of the RAMS Final Work Plan.

## 4.2 Laboratory Analytical Sample Requirements

All surface soil and sediment samples were submitted to a laboratory for analysis for total metals for soil samples and analysis for metals, conductivity, pH, and acidity of the water leachate from the soil.

Laboratory analytical sample requirements are given in the following table:

**TABLE 4-1: LABORATORY ANALYTICAL SAMPLE REQUIREMENTS**

| Parameter | Field | Quality Control Duplicate | Total |
|---|---|---|---|
| Soil Samples | | | |
| Surface soil ** | 27 | 4 | 31 |
| Sediment ** | 4 | 1 | 5 |
| Water Leachate Samples* | | | |
| Surface soil | 27 | 4 | 31 |
| Sediment | 4 | 1 | 5 |

* The water leachate sample was derived by leaching the soil sample.
** Metals include Al, As, Ca, Cd, Cr, Cu, Fe, Pb, Mg, Mn, K, Ag, and Zn.

## 4.3 Sample Containers, Preservation and Holding Times

Sample container, preservation, and holding time requirements are given in the following table:

**TABLE 4-2: SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR COMPOSITE SOIL SAMPLES**

| Parameter | Container | Maximum Holding Times | |
|---|---|---|---|
| | | Digestion | Analysis |
| **Composite Soil Sample*** | | | |
| Metals[1] | 1 x 8 ox Glass | 6 months (Mercury – 28 days) | 6 months (Mercury – 28 days) |
| **Water Leachate**** | | | |
| Leachate Metals[1] | | 6 months (Mercury – 28 days) | 6 months (Mercury – 28 days) |
| Leachate pH | | | ASAP*** |
| Leachate Acidity | | | ASAP*** |
| Conductivity | | | ASAP*** |

* One 8 oz jar obtained in the field from each area is sufficient for all analyses.
** The water leachate process is performed in the laboratory by the method described in the Site Specific Work Plan..
*** ASAP in this instance means as soon as possible after leachate is obtained.
[1] Al, As, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, K, Ag, Zn

## 4.4 Sample Labeling and Shipment

Immediately after sample collection, the samples were preserved as noted above, labeled, and placed into a cooler. Labeling was performed as specified in the SSA to the RAMS Work Plan. The Laboratory Identification Management System (LIMS) number was **LIMS # 6695.** The samples were stored in a secured place until shipped in a cooler with the appropriate chain-of-custody forms sealed and shipped by overnight delivery to the USACE ECB Laboratory located in Omaha, Nebraska.

## 4.5 Sample Analysis

All samples were held at the ECB Laboratory and analyzed in the same sample analytical batch**.** The following analytical methods were used for the field samples and appropriate required quality control samples for this site:

| Parameter | Method | Matrix |
|---|---|---|
| Metals | EPA Method 3050/6010B | Soil |
| | | |
| Water Leachate** | | |
| Metals | EPA Method 3010/6010B | aqueous leachate |
| pH | USDA 8C | aqueous leachate |
| Acidity | EPA 305.1 | aqueous leachate |
| Conductivity | 9050A | aqueous leachate |

** The water leachate process is performed in the laboratory as is described in the Site Specific Work Plan.

## 4.6 Analytical Results

The analytical results for this project are provided in Tables 1 and 2 of the CDQAR. These tables include the MRL, the analytical results with units specified, and any data qualifiers. Data qualifiers are defined on the table and are described in the Chemical Data Quality Assessment Report (CDQAR), which is included as an attachment to this document (Attachment 1).

# 5 QUALITY CONTROL REVIEW

Quality control review consists of an evaluation of the field and analytical procedures and a review of the data to ensure that the appropriate QC compliance was met.

## 5.1 Field Quality Control

The project team reviewed all field documentation (e.g. field data sheets, chain-of-custody forms, etc.) for completeness. A review of the placement or coordinates of the sample was performed to ensure that this correlates to sample nomenclature. Placement and frequency of the quality control samples were reviewed to ensure compliance to set criteria.

## 5.2 Laboratory Quality Control

Laboratory Quality Control is provided in the CDQAR, which is included as an attachment to this document (Attachment 1).

## 5.3 Data Validation

Data validation information is provided in the CDQAR, which is included as an attachment to this document (Attachment 1).

## 5.4 Data Quality Summary

The CDQAR presents, in specific terms, the quality control practices utilized to achieve the goals of the site investigation at North Fork of Clear Creek, Colorado. Samples were also collected and analyzed in accordance with ASTM and EPA methods and laboratory specific QA/QC procedures were used. These procedures were followed to generate high quality data.

The quality issues addressed in the CDQAR do not impact the usability of the data. The required qualifications have been applied to the data in Table 2 of the CDQAR. The reviewed data are usable and are suitable for addressing the overall objectives of this investigation.

# 6 SUMMARY

The project was executed in accordance with the RAMS Work Plan and the Site Specific Addendum for North Fork of Clear Creek in Colorado. Samples were also collected and analyzed in accordance with ASTM and EPA methods and laboratory specific QA/QC procedures were used. These procedures were followed to generate high quality data. The minor quality issues addressed in the CDQAR do not impact the usability of the data. The reviewed data are usable and are suitable for addressing the overall objectives of this investigation.

# FIGURE 3-1

# APPENDIX A

# PHOTOGRAPHS OF MINE WASTE PILES

# APPENDIX B

# FIELD DATA SHEETS

# ATTACHMENT 1

# CHEMICAL DATA QUALITY ASSESSMENT REPORT (CDQAR) FOR SURFACE SOIL SAMPLES NORTH FORK OF CLEAR CREEK, COLORADO